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LXXXVIII. *Extract of a Letter from John Lining, M. D. of Charles Town, in South Carolina, to Charles Pinckney, Esq; in London: With his Answers to several Queries sent to him concerning his Experiment of Electricity with a Kite.*

Charles Town, January 14, 1754.

Read May 4, 1754. **I**nclosed I send you answers to the queries, which you sent me concerning the experiment with the kite.

Since I made that experiment last May, I have not had an opportunity of making any more, having been confined all the summer and autumn with the gout, which perhaps prevented my meeting with the same unhappy fate with professor Richman. In the London Daily Advertiser, Thursday 27 September last, there is a more particular account of that unhappy accident. From that account it appears, that the professor had a wire, which came down from the iron rod, erected on his house, through the gallery-ceiling, to an iron bar, which stood in a glass vessel, which was filled with water and filings of brass; and that the professor stood so near that iron rod, that his face was within a foot of it. Now if there was no wire, that went from that iron rod, or from any part of the wire above it, into the earth, it is no great wonder, that the professor was killed. I should be extremely glad to be informed, whether the iron rod upon his house, at the time the experiment was made,

made, had any communication, by means of metal, with the earth. For, if it had, there is then more danger attending these experiments than I imagined. It is likewise said in that paper, that from the electrical needle, which he observed, there was no danger. I am at a loss to know what that electrical needle was, and should be glad to be informed. I know, that a magnetic needle placed on a sharp point upon the prime conductor, as soon as the conductor is sufficiently electrified, will move round with so great rapidity, that in the dark the electricity, thrown off from both poles of the needle, will appear like a circle of fire.

Answers of Dr. Lining to the Queries sent to him.

Query 1. In what manner, and of what materials, was your kite, and the string, by which you flew it, made? and to what height did it rise above the earth?

Answer. The kite, which I used, was made in the common way; only, in place of paper, I covered it with a silk, called *alamode*. The line was a common small hempen one of three strands. A silk line, except it had been kept continually wet, would not conduct the electricity; and a wire, besides other inconveniencies, would have been too heavy. I had not any instrument, whereby I could take the height of the kite; but, I believe, it was at least 250 feet high. It was flown in the day-time.

Query 2. You say also, “ *All* the electrical fluid, “ or lightning, was drawn from the cloud, and discharged in the air; and a greater degree of serenity succeeded, and no more of the awful noise “ of

“ of thunder, before expected, was heard.” Now I should be glad you would inform us, whether the serenity in the air you mention, was such, as generally follows, after the clouds in the summer thunderstorms have discharged several loud thunder-claps; and whether any flashes of lightning appeared in the skies, after you had discharged the cloud of its lightning by the kite, as commonly do after a thunder-storm is over in a summer’s night? For if there were no appearance of such flashes, then, I think, your assertion, that *all* the electric fluid, or lightning, was drawn from the cloud, stands fully proved; but if there were such flashes after, I conceive there must have been some of the electrical matter left behind.

Answer. During the time of my drawing the lightning from the cloud, and for some little time afterwards, it rained; by which means, the body of the cloud being diminished, a greater degree of serenity necessarily succeeded; and the quantity of lightning extracted from the cloud, or rather its atmosphere, proved sufficient to prevent any thunder in town that afternoon; though there was a great appearance of thunder before the kite was raised. But whether the same serenity succeeded, as frequently happens after a thunder-storm, and whether there were any flashes of lightning seen in the evening, I cannot now recollect. If such flashes had afterwards been seen in the skies, as is common in a summer’s evening, especially after a thunder-storm, those might proceed from other clouds, which had passed the town, at too great a distance to be acted upon by the kite.

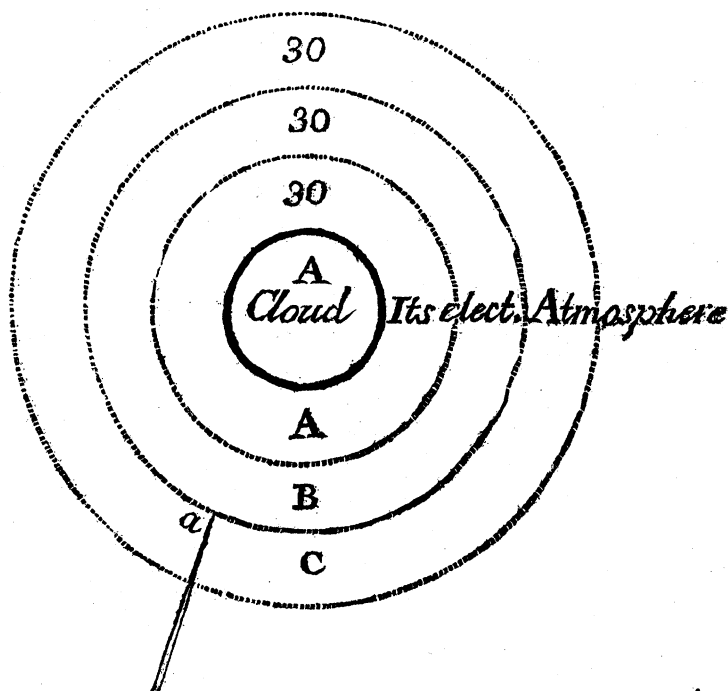
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If three electrified clouds (which we shall call) *A*, *B*, and *C*, pass from west to east, and are so situated to one another, and to this town, that the cloud *B* is not only in breadth and length equal to the area of the town, but vertical over it, having an electrical atmosphere, which reaches low enough to be acted upon by sharp points, either raised by kites, or erected upon the houses; then the cloud *B* may be so far deprived of its electricity, before it has passed over the town, as to be incapable of giving any flashes of lightning, till it meets with other less electrified clouds, and approaches very near them. But the clouds *A* and *C*, being at too great a distance, in their passage by the town, to be acted upon by those points, fly on in their electrical state, till they meet with clouds, or other bodies, in a non-electric state, or at least with those, which have a less degree of electricity. If the cloud (suppose) *A* meets, or rather approaches afterwards near enough, the cloud *B*, which was deprived of great part of its electricity, or any other non-electric cloud, it will discharge at once part of its electricity into *B*, or the non-electric cloud; and if into the latter, which we shall call *D*, in that explosion, it will deliver so much of its electricity to *D*, as will make an equilibrium in electricity between them; *i. e.* if *A* had 100 degrees of electricity, and *D* only its natural quantity, after the explosion, each will have 50. Then *D* is in a condition to flash into a non-electric cloud; but that explosion will be much weaker than that was from *A*; because *D*, in exploding into a non-electric cloud, will only part with one-half (if those two clouds are of equal dimensions); that is with 25 de-
grees

grees of its electricity. But if it exploded upon a house, tree, or the like, the loudness of that explosion would be equal to the first; as in this case, it has an opportunity of parting, at once, with its whole charge of electricity, which, by supposition, was 50. Hence we see, that one electrified cloud *only* may be productive of many claps of thunder; and that those proceeding originally from that cloud, will become weaker, as the whole quantity of electricity may at last be divided amongst many clouds; and from hence several phænomena, which appear during a thunder-storm, and which succeed it, may be accounted for. If therefore any flashes of lightning were seen that evening, after the experiment with the kite, you see how those might be produced, whether the cloud was deprived of its electricity or not.

Electrified clouds have an electrical atmosphere, as well as the prime-conductor, when it is electrified; and the diameter of that atmosphere, *cæteris paribus*, will bear some proportion to the size of the cloud. My smallest prime-conductor is two inches and an half in diameter; and when it is fully charged, its atmosphere extends to the distance of about three feet from the surface of the conductor. How great then must the extent be of the atmosphere, which surrounds a large cloud fully electrified? It perhaps may extend to many hundreds of feet round the cloud, and may even reach so low as to touch the surface of the earth: And when that is the case, a man, or a rod of metal, placed on a cake of resin on the ground, may be electrified, and yield sparks of fire.

When a sharp point is presented to that atmosphere, it cannot deprive the cloud of its whole quantity of electricity, except the sharp point be so near, that the cloud may explode upon it; and, in that case, the cloud must have a communication with the ground, by means of some non-electric body. Suppose an electrified cloud to have an atmosphere, which extends round it to the distance of 90 feet from its surface; and let that atmosphere be divided into three parts *A*, *B*, and *C*, each 30 feet in diameter: Now if a sharp metalline point (*a*) erected on a kite, or otherwise, is placed either vertically or horizontally in the most interior part of the atmosphere *C*, that point will continue to act till a quan-



tity of the lightning is drawn off, equal to the quantity which was contained in that atmosphere, and no longer. For then the semi-diameter of the atmosphere being reduced to 60 feet, every part of it is above, and not in contact with, the sharp point (*a*), and consequently beyond its sphere of action. But let the sharp point be then advanced into the atmosphere *B*, and it will act as before, &c.

The truth of this, however contradictory it may be, to the general opinion of the action of sharp points, in drawing off the electricity or lightning *, may be illustrated by the following experiment on the prime-conductor. Electrify the prime-conductor in a dark room, and draw back the globe to a sufficient distance from the prime-conductor, to prevent its being supplied with any more electricity from the globe, while you are taking off the electrical atmosphere with a sharp point. Bring then a sharp point, either vertically or horizontally, or in any other direction, within two feet of the prime-conductor; and the point, for some time, will appear luminous. After that light disappears, advance the point three or four inches nearer to the conductor, and you will observe the same phenomena as before; and by advancing the point gradually in this manner, as the light upon it disappears, the point will be alternately luminous and dark, till you have taken off the whole atmosphere in different laminæ. As the

* Mr. Franklin says, speaking of sharp points, " At whatever distance you see the light, you may draw off the electrical fire." page ii.

point appears more and more luminous, the nearer that it approaches the prime-conductor, the electrical atmosphere may have different degrees of density, being perhaps denser near the prime-conductor, and rarer at a greater distance from it. If a phial is charged on the prime-conductor, when this experiment is made, the light upon the sharp point will be much greater, and continue longer.

Query 3. Did you make any trial, at what distance you could kill an animal with a discharge of the electrical fluid from the key or the bottle suspended to it?

Answer. I have not hitherto had an opportunity of making any such experiments with the kite. But as to the first, I apprehend, that no animal could be killed by the discharge of any quantity of electricity accumulated on the key; as the key in that experiment answers the same end as the prime-conductor, and, like it, is capable of receiving *only* a certain charge of electricity, except the lightning flows down the line too fast, or the kite be so near the cloud that it may explode, when one standing on the ground approaches the key to draw sparks from it: but such an explosion would probably be fatal to the operator.

When a phial is suspended to the key, after it has received its charge, if you let it continue hanging on the key, the surcharge will fly off from the hook of the phial, and the phial, when charged in that manner, will not give a greater shock than if it had been charged in the common way with the globe.

J. L.